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(54) **Process for partial oxidation of a hydrocarbon-containing gaseous fuel.**

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## Description

The invention relates to a process for partial oxidation of a hydrocarbon-containing gaseous fuel using a multi-orifice burner.

In particular, the invention relates to a process for partial oxidation of a hydrocarbon-containing gaseous fuel wherein an oxygen-containing gas and a hydrocarbon-containing gaseous fuel are supplied to a gasification zone through a multi-orifice burner comprising a concentric arrangement of 2 oxygen-passages or channels and 2 fuel passages or channels, and wherein autothermically a gaseous stream containing synthesis gas is produced under partial oxidation conditions.

The oxygen-containing gas is usually air or pure oxygen or a mixture thereof. In order to control the temperature in the gasification zone a moderator gas can be supplied to said zone.

More in particular, the invention relates to a process as described in the foregoing, wherein a gas such as natural gas, refinery gas, methane and the like is suitable as a fuel gas.

In such processes it is necessary to ensure a good and rapid contacting or mixing of the fuel and the oxygen-containing gas in order to obtain an excellent gasification process.

Further, in such process the lifetime of the equipment can be elongated by the reduction of the convective and radiative heat-flux via flame-lift without distorting the process performance.

It is an object of the invention to provide a process for partial oxidation of a hydrocarbon-containing gaseous fuel wherein a rapid and intimate mixing of the reactants outside the concentric arrangement is obtained. It is another object of the invention to provide a process for partial oxidation of a hydrocarbon-containing gaseous fuel wherein the mixing energy of oxygen and fuel is provided by the high velocity fuel flow.

It is another object of the invention to provide a process for partial oxidation of a hydrocarbon-containing gaseous fuel wherein pressure losses are minimized and wherein shorter reactor lengths are made possible, since the effective reactor residence time is maintained via the reduction of the effective burner velocity and the mixing distance downstream the burnerface.

It is still another object of the invention to provide a process for partial oxidation of a hydrocarbon-containing gaseous fuel wherein highly exothermic reactions are prevented in the region where the relatively hot syngas from the reactor mixes with the reactants from the third concentric channel.

The invention therefore provides a process for partial oxidation of a hydrocarbon-containing gaseous fuel comprising the steps of supplying an oxygen-containing gas and a hydrocarbon-containing gaseous fuel to a gasification zone through a multiorifice reactor-mix burner comprising a concentric arrangement of 2 oxygen passages or channels and 2 fuel passages or channels, and producing auto-thermically a gaseous stream containing synthesis gas under partial oxidation conditions, and further comprising the steps of supplying oxygen-containing gas through the central channel of the concentric arrangement at a relatively low velocity of 5-45 m/s; supplying hydrocarbon-containing gaseous fuel through the first concentric channel encircling the central channel at a relatively high velocity of 50-150 m/s; supplying oxygen-containing gas through the second concentric channel encircling the first channel at a relatively low velocity of 5-45 m/s; and supplying hydrocarbon-containing gaseous fuel and/or a moderator for controlling the temperature in the gasification zone through the third concentric channel encircling the second channel at a relatively low velocity of 5-45 m/s, and wherein the respective velocities are measured at the outlet of the said respective concentric channels into the gasification zone.

It can be remarked that EP-A-98043 discloses a premix burner to be used in coal gasification. This burner comprises four coaxial conduits.

Further, US-A-4,525,175 discloses a burner for partial oxidation of slurries of solid fuel wherein the burner has a central conduit and three concentric annular passages.

However, these citations do not disclose at all the specific process and process conditions for partial oxidation of a hydrocarbon-containing gaseous fuel.

In advantageous embodiments of the invention 30 to 45 mass per cent of the oxygen-containing gas is supplied through the said central channel and 10 to 20 mass per cent of the fuel is supplied through the third concentric channel.

The velocity measurement can be carried out in any way suitable for the purpose and will not be described in detail.

In still another advantageous embodiment of the invention the oxygen-containing gas and/or the fuel contain steam or carbon dioxide as a moderator. In still another advantageous embodiment of the invention the gasification process is carried out at a pressure of 0.1-12 MPa.

In still another advantageous embodiment of the invention the hydrocarbon containing fuel is a gas, for example methane, natural gas or refinery gas.

The fuel and the oxygen-containing gas are supplied to the gasification zone through a concentric arrangement of 2 oxygen passages and 2 fuel passages. A central channel for oxygen (advantageously mixed with a moderator) supply is surrounded by a first annular channel for fuel supply. The said first annular channel is surrounded by a second annular channel for oxygen (advantageously mixed with a moderator) supply and the said second channel is surrounded by a third annular channel for fuel and/or moderator supply.

Multi-orifice burners comprising arrangements of annular concentric channels for supplying oxygen and fuel to gasification zones are known as such and the mechanical details thereof will not be described.

According to the invention the oxygen and the fuel are supplied to the gasification zone through the respective channels at specific low velocities and specific mass distribution in order to obtain low pressure loss, rapid and intimate mixing of reactants, effective long reactor residence time and flame lift.

The invention will now be described in more detail by reference to the following examples.

Tests have been carried out under the following conditions:

a)	<u>fuel</u>	<u>Example I</u>	<u>Example II</u>
	mass flow (kg/s)	3.172	4.446
5	density (kg/m <sup>3</sup> )	14.0	16.3
	temperature (K)	673	672
	composition vol. %		
10	CO	7.374	0.336
	CO <sub>2</sub>	15.57	3.798
	CH <sub>4</sub>	68.57	84.05
15	other hydrocarbons	1.702	7.832
	H <sub>2</sub>	6.474	3.286
	N <sub>2</sub>	0.310	0.698
20	b) <u>oxidizer</u>	<u>Example I</u>	<u>Example II</u>
	mass flow oxygen (kg/s)	2.703	4.954
	mass flow steam (kg/s)	0.3808	0.2207
25	density (kg/m <sup>3</sup> )	25.7	34.2
	temperature (K)	519	534
	composition vol. %		
30	H <sub>2</sub> O	20.03	7.334
	N <sub>2</sub>	0.12	0.4633
	O <sub>2</sub>	79.85	92.203
35	c) <u>Production:</u>		
	CO + H <sub>2</sub> (nm <sup>3</sup> /day dry)	600.10 <sup>3</sup>	1275.10 <sup>3</sup>
40	d) <u>Geometry at burner face:</u>	<u>Example I</u>	<u>Example II</u>
	diameter central tube (mm)	55.28	64.00
	slot width first channel (mm)	13.88	11.50
45	" " second " (mm)	12.03	13.72
	" " third " (mm)	6.34	7.14
	mixing distance downstream of burnerface		
50	for macro mix of reactants (m)	0.150	0.11

e) Distribution of mass flow and velocitymass ratio (%)

central channel (oxidizer)	40	40
first channel (fuel)	80	80
second " (oxidizer)	60	60
third " (fuel)	20	20

Velocity at burner face

oxidizer via central tube (m/s)	20	20
fuel via first channel (m/s)	60	80
oxidizer via second channel (m/s)	20	20
fuel via third channel (m/s)	20	20

f) reactor

pressure (MPa)	3.8	4.9
temperature (K)	1675	1600

g) Typical raw syngas composition %vol dry

CO	40.4	35.6
CO <sub>2</sub>	5.2	2.0
H <sub>2</sub>	54.3	61.0
CH <sub>4</sub>	0.1	1.4

**Claims**

1. A process for partial oxidation of a hydrocarbon-containing gaseous fuel comprising the steps of supplying an oxygen-containing gas and a hydrocarbon-containing gaseous fuel to a gasification zone through a multi-orifice reactor-mix burner comprising a concentric arrangement of 2 oxygen passages or channels and 2 fuel passages or channels, and producing auto-thermically a gaseous stream containing synthesis gas under partial oxidation conditions, and further comprising the steps of supplying oxygen-containing gas through the central channel of the concentric arrangement at a relatively low velocity of 5-45 m/s; supplying hydrocarbon-containing gaseous fuel through the first concentric channel encircling the central channel at a relatively high velocity of 50-150 m/s; supplying oxygen-containing gas through the second concentric channel encircling the first channel at a relatively low velocity of 5-45 m/s; and supplying hydrocarbon-containing gaseous fuel and/or a moderator for controlling the temperature in the gasification zone through the third concentric channel encircling the second channel at a relatively low velocity of 5-45 m/s, and wherein the respective velocities are measured at the outlet of the said respective concentric channels into the gasification zone.
2. The process as claimed in claim 1 characterized in that the oxygen-containing gas and/or the fuel is mixed with a moderator.
3. The process as claimed in claim 1 characterized in that the moderator is steam or carbon dioxide.
4. The process as claimed in any one of claims 1-3 characterized in that the process is carried out at a

pressure of 0.1-12 MPa.

5. The process as claimed in any one of claims 1-4 characterized in that 30-45 mass per cent of the oxygen-containing gas is supplied through the said central channel.
6. The process as claimed in any one of claims 1-5 characterized in that 10-20 mass per cent of the fuel is supplied through the said third concentric channel.
7. The process as claimed in any one of claims 1-6 characterized in that said hydrocarbon-containing fuel gas is natural gas or refinery gas.
8. The process as claimed in claim 7 characterized in that said fuel gas is methane.

#### Revendications

1. Procédé d'oxydation partielle d'un combustible gazeux contenant un hydrocarbure comprenant les étapes de fourniture d'un gaz contenant de l'oxygène et d'un combustible gazeux contenant un hydrocarbure à une zone de gazéification par l'intermédiaire d'un brûleur de mélange de réacteur multi-orifices comprenant une disposition concentrique de deux passages ou canaux d'oxygène et deux passages ou canaux de combustible, et produisant de façon autothermique un courant gazeux contenant un gaz de synthèse dans des conditions d'oxydation partielle, et comprenant en outre les étapes de fourniture d'un gaz contenant de l'oxygène par l'intermédiaire du canal central de la disposition concentrique à une vitesse relativement faible de 5-45 m/s; fourniture du combustible gazeux contenant un hydrocarbure à travers le premier canal concentrique encerclant le canal central à une vitesse relativement élevée de 50-150 m/s; fourniture d'un gaz contenant de l'oxygène à travers le second canal concentrique encerclant le premier canal à une vitesse relativement faible de 5-45 m/s; et fourniture d'un combustible gazeux contenant un hydrocarbure et/ou un modérateur pour régler la température dans la zone de gazéification par l'intermédiaire du troisième canal concentrique encerclant le second canal à une vitesse relativement faible de 5-45 m/s, et où les vitesses respectives sont mesurées à la sortie desdits canaux concentriques respectifs la zone de gazéification.
2. Procédé selon la revendication 1, caractérisé en ce qu'on mélange le gaz contenant de l'oxygène et/ou le combustible avec un modérateur.
3. Procédé selon la revendication 1, caractérisé en ce que le modérateur est la vapeur ou le dioxyde de carbone.
4. Procédé selon l'une quelconque des revendications 1-3, caractérisé lorsque le procédé est réalisé à une pression de 0,1-12 MPa.
5. Procédé selon l'une quelconque des revendications 1-4, caractérisé en ce qu'on fournit 30-45 pour cent massique du gaz contenant de l'oxygène à travers ledit canal central.
6. Procédé selon l'une quelconque des revendications 1-5, caractérisé lorsqu'on fournit 10-20 pour cent massique du combustible à travers ledit troisième canal concentrique.
7. Procédé selon l'une quelconque des revendications 1-6, caractérisé lorsque ledit gaz combustible contenant un hydrocarbure est du gaz naturel ou du gaz de raffinerie.
8. Procédé selon la revendication 7, caractérisé en ce que ledit gaz combustible est le méthane.

#### Patentansprüche

1. Ein Verfahren zur Partialoxidation eines Kohlenwasserstoff enthaltenden gasförmigen Brennstoffes, umfassend die Schritte des Einspeisens eines sauerstoffhaltigen Gases und eines Kohlenwasserstoff enthaltenden gasförmigen Brennstoffes in eine Vergasungszone durch einen Reaktor-Misch-Brenner mit mehreren Öffnungen, umfassend 2 Sauerstoffleitungen oder -kanäle und 2 Brennstoffleitungen oder -kanäle in konzentrischer Anordnung, und des Herstellens auf auto-thermische Weise unter Partialoxi-

dationsbedingungen eines gasförmigen Stroms, enthaltend Synthesegas, und ferner umfassend die Schritte des Einspeisens von sauerstoffhaltigem Gas durch den Zentralkanal der konzentrischen Anordnung mit einer relativ geringen Geschwindigkeit von 5-45 m/s; des Einspeisens von Kohlenwasserstoff enthaltendem gasförmigem Brennstoff durch den ersten konzentrischen Kanal, der den Zentralkanal umschließt, mit einer relativ hohen Geschwindigkeit von 50 bis 150 m/s; des Einspeisens von sauerstoffhaltigem Gas durch den zweiten konzentrischen Kanal, der den ersten Kanal umschließt mit einer relativ geringen Geschwindigkeit von 5 bis 45 m/s; und des Einspeisens von Kohlenwasserstoff enthaltendem gasförmigem Brennstoff und/oder eines Moderators zum Kontrollieren der Temperatur in der Vergasungszone durch den dritten konzentrischen Kanal, der den zweiten Kanal umgibt, mit einer relativ geringen Geschwindigkeit von 5 -45 m/s, wobei die entsprechenden Geschwindigkeiten am Auslaß der genannten entsprechenden konzentrischen Kanäle in die Vergasungszone gemessen werden.

2. Das Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das sauerstoffhaltige Gas und/oder der Brennstoff mit einem Moderator gemischt werden.

3. Das Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der Moderator Wasserdampf oder Kohlendioxid ist.

4. Das Verfahren nach einem der vorstehenden Ansprüche 1 bis 3, dadurch gekennzeichnet, daß das Verfahren bei einem Druck von 0,1 bis 12 MPa durchgeführt wird.

5. Das Verfahren nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß 30 bis 45 % der Gewichtsmenge des sauerstoffhaltigen Gases durch den genannten zentralen Kanal zugespeist werden.

6. Das Verfahren nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß 10 bis 20% der Gewichtsmenge des Brennstoffes durch den genannten dritten konzentrischen Kanal zugespeist werden.

7. Das Verfahren nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß das genannte Kohlenwasserstoff enthaltende Brennstoffgas Erdgas oder Raffinerie-Gas ist.

8. Das Verfahren nach Anspruch 7, dadurch gekennzeichnet, daß das genannte Brennstoffgas Methan ist.

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